THE OPEN UNIVERSITY OF SRI LANKA

009

FACULTY OF ENGINEERING TECHNOLOGY

DIPLOMA IN TECHNOLOGY – LEVEL 4

Final Examination – Academic Year 2006/2007

ECX4240 / ECD2220 - AUTOMOTIVE ELECTRONICS

DATE: May 19, 2007 **Time: 0930 – 1230 hrs**

IMPORTANT:

- **Answer Question 01, which is compulsory and two others. Question 1 carries 40 marks, whereas the others each 30 marks. Each question has two parts, Part A and Part B and both parts should be attempted.**
- **Present briefly important but relevant facts and information. Any missing information can be sensibly and reasonably assumed provided that you state them clearly. Wherever necessary, use neatly drawn sketches to explain answers.**

Question 01

Part A

The circuit shown in ***Figure Q 01.a*** is an OP-Amp comparator used to detect the availability of light. The light dependent resistor (LDR) has a resistance of 200 Ω at one threshold point in the presence of light and 130 KΩ at the next threshold point in the dark.

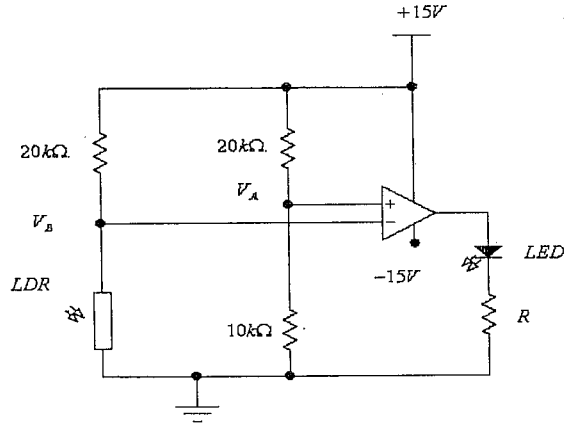

Figure Q 01.a

Answer the following questions:

a) What is the function of a Comparator?

b) Determine the states of the LED at the two threshold points.

c) What is the threshold voltage at which the LED changes its state?

d) Select the suitable value for the resistor **R** in series with the LED to function the circuit accordingly, and state the reason for your choice.

(20 Marks)

Part B

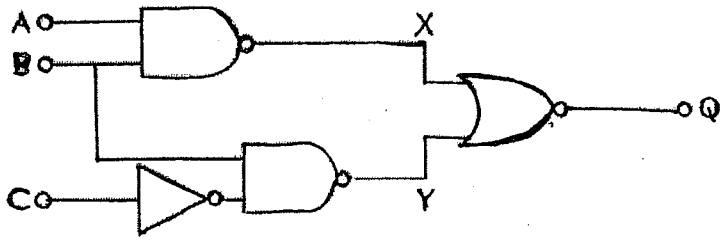

Figure Q 01.b

a) Write down Boolean expressions for the signals at points X, Y, and Q in terms of the inputs A, B, and C in the logic circuit shown in ***Figure Q 01.b***.

b) Complete the truth table below for the signals at X, Y, and Q in the logic circuit shown in the above figure.

Table 01

A	B	C	X	Y	Q
0	0	0			
0	0	1			
0	1	0			
0	1	1			
1	0	0			
1	0	1			
1	1	0			
1	1	1			

c) Use K map and draw the simplified logic circuit, which has the same function as that of the given circuit above.

d) Design an Ex-NOR (Exclusive NOR) Gate using only

(i) NAND gates

(ii) NOR Gates.

(20 Marks)

Question 02

Part A

A common type of an amplifier used in electronic circuits is the *voltage buffer*, sometimes known as a *voltage follower*. There are two simple forms of this circuit as shown in ***Figure Q02.a and Figure Q02.b***, one using a single transistor and the other using an integrated circuit called an operational amplifier:

Transistor voltage buffer

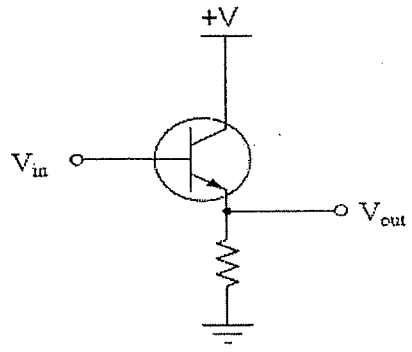

Figure Q02.a

Op-amp voltage buffer

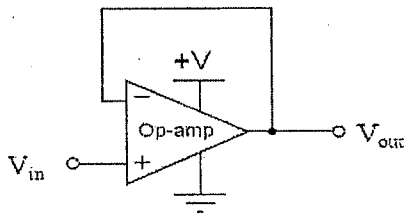

Figure Q02.b

a) Gain is an important parameter of every amplifier. Explain what "gain" is, and write a general equation to define gain in terms of V_{out} and V_{in}.

b) The voltage gain of each of the above devices shown in the figures is unity (AV = 1). What is the use of each amplifier when none of them amplify the voltage of its input signal?

c) If the output voltage is same magnitude as the input voltage, does each circuit amplify any other parameter of the relevant circuit?

(15 Marks)

Part B

A solid-state electronic switch is required to control a 6 Volt, 21-Watt lamp from the output of an OP-Amp.

(a) Name **two** solid-state *electronic devices* that can be used as switches.

(b) Draw a circuit diagram to illustrate how one of these devices could be used to control the lamp. Label the terminals of *the chosen device*, *comparator output that controls the lamp.*

(c)

(i) Is it possible to use any other electromagnetic device to control the lamp? If so, what is it?

(ii)What are the other components that you would require with the above electromagnetic device in a circuit to protect the op-amp?

(15 Marks)

Question 03

Part A

a) Use a Karnaugh map to simplify each of the following functions to a minimum sum-of-products form:

$$X = \bar{A}B\bar{C} + A\bar{B}C + A\bar{B}\bar{C} + \bar{A}B\,C$$

$$X = A\bar{C}\,[B + A\,(\bar{B} + C)]$$

$$X = \bar{D}E\,\bar{F} + \bar{D}E\,F + DE\,F$$

b) Tabulate the truth table for a "**Master – Slave JK flip-flop**".

c) Draw the diagram of a 3-bit binary asynchronous "**Up Counter**" using JK flip-flops.

(15 Marks)

Part B

Consider the common emitter amplifier circuit shown in the ***Figure Q 03***. The amplifier is to be used to amplify audio signal in the range 20 Hz to 20 kHz. If the quiescent collector current is set at 1 mA and the gain at 50;

a) Determine the suitable values for R_C, R_E, R_1 and R_2. Assume $V_{BE} = 0.6V$ and $h_{FE} = 100$

b) What is the input impedance of the amplifier?

c) Determine the suitable value for C_1.

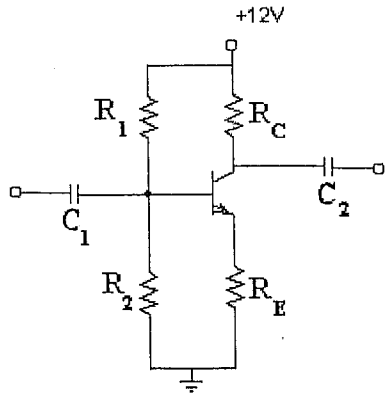

Figure Q 03

(15 Marks)

Question 04

Part A

Computer control systems are employed to continuously monitor the operating conditions of modern vehicles. Computers through sensors receive information on several variables to be monitored and use this information to control different units and sub-units of a vehicle through the use of actuators. Such monitoring and controlling systems enable making minor adjustments, so that entire system works with better accuracy and shorter application and response time compare to their equivalent mechanical systems of older vehicles.

a) List three different types of sensors commonly used on vehicles.
b) Explain the operating principle of one of the above sensors.
c) What are the important factors those need to be considered when selecting a sensor for a typical application?

(15 Marks)

Part B

A 555 timer IC is used to produce clock pulses as shown in ***Figure Q 04.a***. The pine diagram of the 555-timer is shown in ***Figure Q 04.b***.

a) Complete the diagram in ***Figure Q 04.b*** for the *astable multivibrator* by adding *two resistors R_1 and R_2 and a capacitor C*. Label the components you have added.

b) Calculate the frequency of the produced clock pulse if R_1 is 1 kΩ, R_2 is 10 kΩ, and C is 1 mF.

c) What is meant by the "Time Constant" in RC circuits?

(15 Marks)

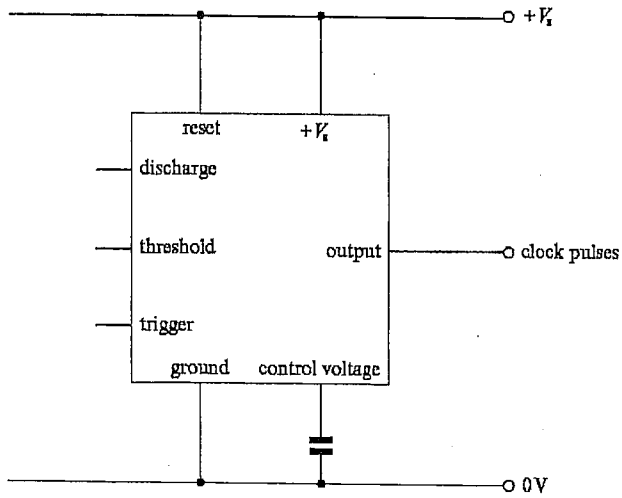

Figure Q 04.a

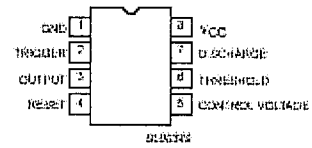

Figure Q 04.b

Question 05

Part A

Use the circuit diagram shown in ***Figure Q 05.a*** to answer the following questions.

a) What is the type of multivibrator in the circuit given in the below figure? Name the other two types of multivibrators.

b) Do you think that both LEDs can be in the "ON" state at the same time?

c) If 100µF capacitor in the circuit given below is replaced by a 47µF, what will happen to the frequency of the circuit?

(15 Marks)

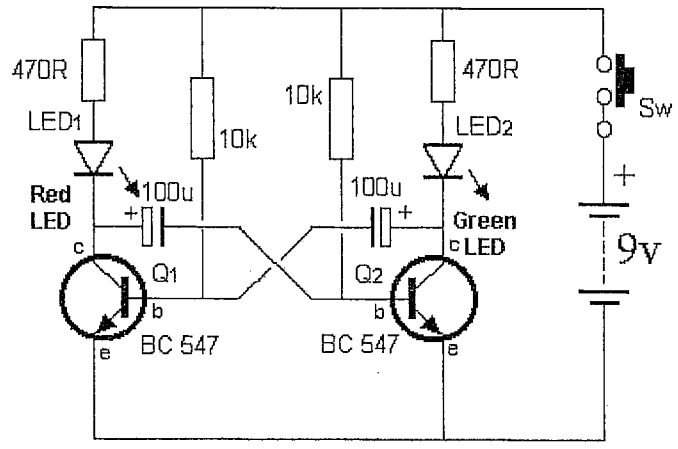

Figure Q 05.a

Part B

a) Briefly explain the following terms with particular reverence to an Analog to Digital Conversion?

i. Sample and Holding

ii. Quantization

iii. Coding

b) The following circuit in ***Figure Q 05.b*** is a basic digital-to-analog converter. It assumes a 4-bit binary number in Binary-Coded Decimal (BCD) format, using +5V as logic "1" and 0V as logic "0". It will convert the applied BCD number to a matching (inverted) output voltage. The digits 1, 2, 4, and 8 refer to relative weights assigned to each input. Thus, 1 is the Least Significant Bit (LSB) of the input binary number, and 8 is the Most Significant Bit (MSB). If digits 8 and 2 → +5V, and digits 1 and 4 → 0V, what is the output voltage of the given ADC?

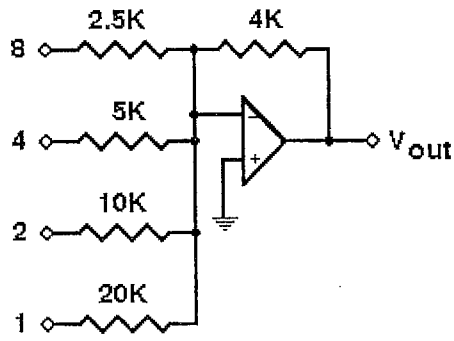

Figure Q 05.b

(15 Marks)